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SITE HYDROGEOLOGY

Stauffer Chemical Company

Chicago Heights, Illinois

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INTRODUCTION

Bruce S. Yare and Associates, Inc. were retained by Stauffer Chemical Company to define hydrogeologic conditions around a closed disposal area at the Chicago Heights, Illinois plant (Figure 1).

From January 8 to 16, 1981, four monitoring wells were installed to increase the areal extent of the existing monitoring well network. The five-inch diameter wells were constructed by drilling 25 to 30 feet to bedrock with a hydraulic rotary rig. Drilling mud was made with bentonite and municipal water. A four-foot long, slotted PVC well screen was attached to steel casing, set in the bottom of the borehole and backfilled with pea gravel. The remaining annulus was filled with neat cement grout. Well development was limited to a short period of air agitation with the rig's compressor.

Information from the monitoring well network, plant production wells, published literature and state records was used to define the water-bearing units and ground-water flow system at the site.

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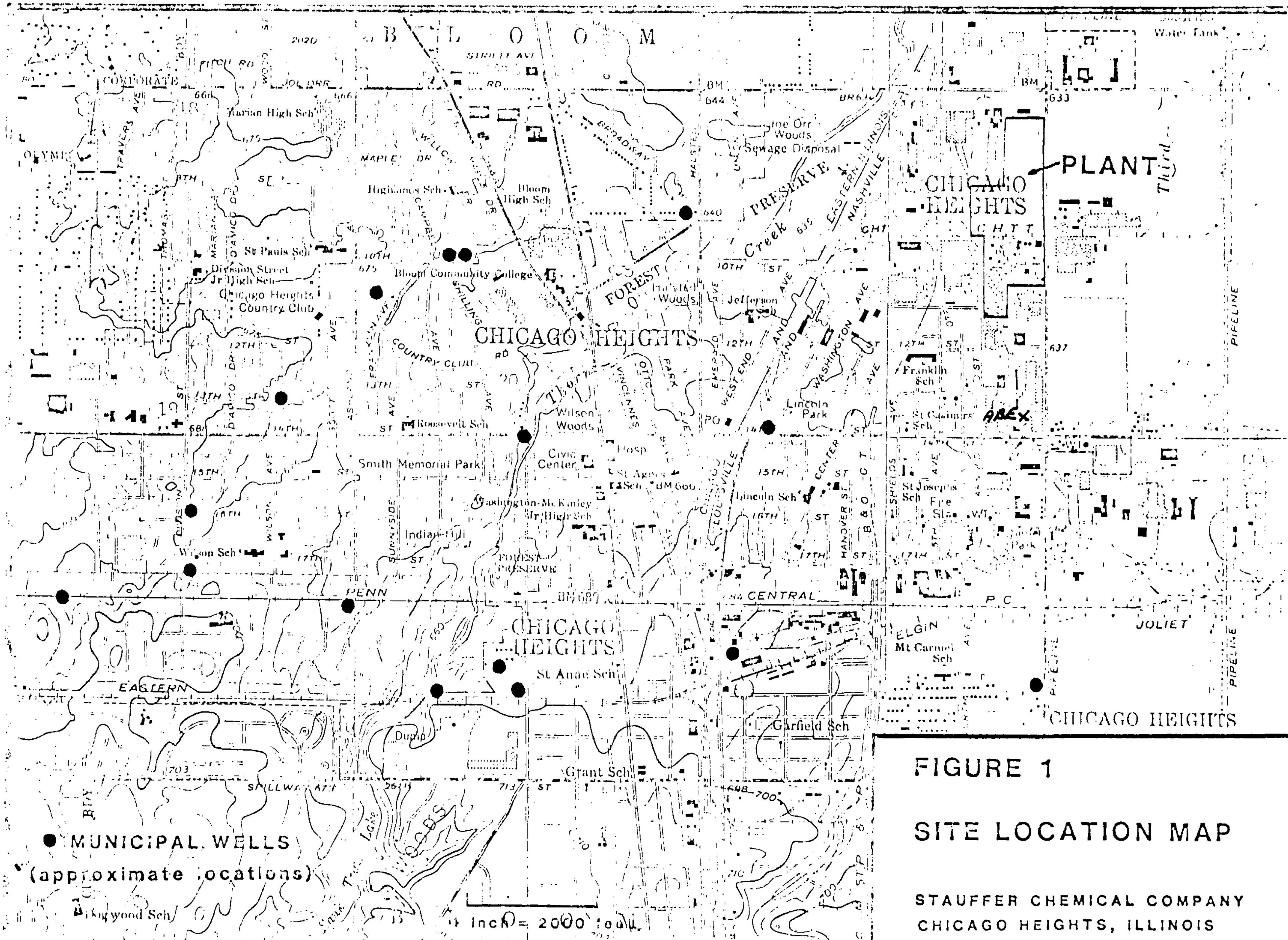


FIGURE 1

SITE LOCATION MAP

STAUFFER CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

GROUND-WATER OCCURENCE

Glacial Drift

All of northern Illinois is blanketed with unconsolidated sediments deposited by or in front of the numerous ice sheets which once covered the region. These sediments, collectively called glacial drift, consist of till, outwash and glacial lake clays. Tills and glacial lake clays are fine-grained, low permeability sediments. Outwash deposits, composed of sand and gravel, are often important aquifers (Table 1).

Surficial sediments in the vicinity of the plant consist of ground moraine and lake plain (Willman, 1971). Ground moraine is till deposited beneath an ice sheet and a lake plain is a till surface eroded flat by glacial lake wave action.

Regionally-extensive outwash deposits underlie the low permeability till at the site. This sand and gravel deposit is forty feet thick southwest of Chicago Heights and thins toward the northeast (Prickett and others, 1964). Soil borings indicate these deposits range from less than three to more than twenty feet in thickness beneath the plant (Appendix A.1).

The entire drift sequence recharges the underlying dolomite aquifer at a rate of approximately 300,000 gpd/sq mi (gallons per

Table 1. Generalized Stratigraphic and Hydrogeologic Section, Stauffer Chemical Company, Chicago Heights, Illinois. (From Hughes and others, 1966.)

SYSTEM	SERIES	MEGA-GROUP	GROUP OR FORMATION	GRAPHIC LOG	THICKNESS (FEET)	DESCRIPTION	AQUIFER SYSTEMS	
QUATERNARY	PLEISTOCENE				0 - 400 +	Unconsolidated ice- and water-laid deposits, pebbly clay (till), silt, sand and gravel, generally discontinuous and interbedded; alluvial silts and sands commonly present along streams.	Glacial drift aquifer system	Sand and gravel beds serve as aquifers. Some wells yield more than 1000 gpm. Large supplies of water available from thick, relatively continuous sand and gravel deposits.
PENNSYLVANIAN					0 - 175	Shale; sandstones, fine grained; limestones; coal; clay.	Shallow bedrock aquifer system	Fractured beds yield small supplies locally.
MISSISSIPPIAN-DEVONIAN / SILURIAN	NIAGARAN				0 - 400 +	Dolomite, very pure to very silty, cherty; shale partings; thin shales and argillaceous beds frequently present in lower parts of Silurian dolomite.		Not consistent; some wells yield more than 1000 gpm. Crevices and solution channels more abundant near bedrock surface.
SILURIAN	ALEXANDRIAN				0 - 165	Upper and middle units—shale, light gray to green, plastic to brittle, some dolomite, silty; dolomite, mostly silty, argillaceous; minor limestone.,		Yields water from fractured beds. Shales, particularly in lower unit, act as confining beds at the base of the shallow bedrock aquifer system.
ORDOVICIAN	CINCINNATIAN		Maquoketa		0 - 250 +	Lower unit—shale, dark gray, black, brown, plastic to brittle; some dolomite in upper part; silty, argillaceous.		
	CHAMPLAINIAN	OTTAWA	Galena Platteville		150 - 350 +	Dolomite, cherty; sandy at base; limestone; shale partings.	Deep bedrock aquifer systems: Cambrian-Ordovician aquifer system	Where below shales, development and yields of crevices are small; where not capped by shales, dolomites are fairly permeable.
			Glenwood St. Peter		75 - 650	Sandstone, fine to coarse grained; shale at top, locally cherty red shale at base.		Glenwood-St. Peter Sandstone. Small to moderate quantities of water. T probably about 15% of that of Cambrian-Ordovician aquifer system.
	CANADIAN	KNOX	Prairie du Chien		0 - 340	Dolomite, sandy, cherty, interbedded with sandstone.		Crevices in dolomite and sandstone generally yield small amounts of water. Dolomite locally well creviced and partly responsible for exceptionally high yields of several deep wells. T probably about 15% of that of Cambrian-Ordovician aquifer system.
CAMBRIAN	CROIXAN		Eminence Potosi		0 - 225	Dolomite, white, fine grained, sandy at base; drusy quartz.		
			Franconia		45 - 175	Sandstone, dolomite, and shale, glauconitic, green to red, micaceous.		
			Ironton Galesville		103 - 275	Sandstone, fine to medium grained, well sorted, upper part dolomitic.		Ironton-Galesville Sandstone. Most productive part of Cambrian-Ordovician aquifer system. T probably about 50% of entire system.
			Eau Claire		235 - 450	Shale and siltstone, dolomitic, glauconitic; sandstone, dolomitic, glauconitic; dolomite, sandy.		Shales generally not water yielding, act as confining bed at the base of the Cambrian-Ordovician aquifer system.
		POTSDAM	Mt. Simon		2000 +	Sandstone, coarse grained, white, red in lower half; lenses of shale and siltstone, red, micaceous.	Mt. Simon aquifer system	Mt. Simon Sandstone. Data sparse; probably less permeable than Ironton-Galesville; quality of water deteriorates with depth.
PRECAMBRIAN						Not penetrated by wells in Chicago area. Nearby wells encounter red or gray granite or similar rocks.		

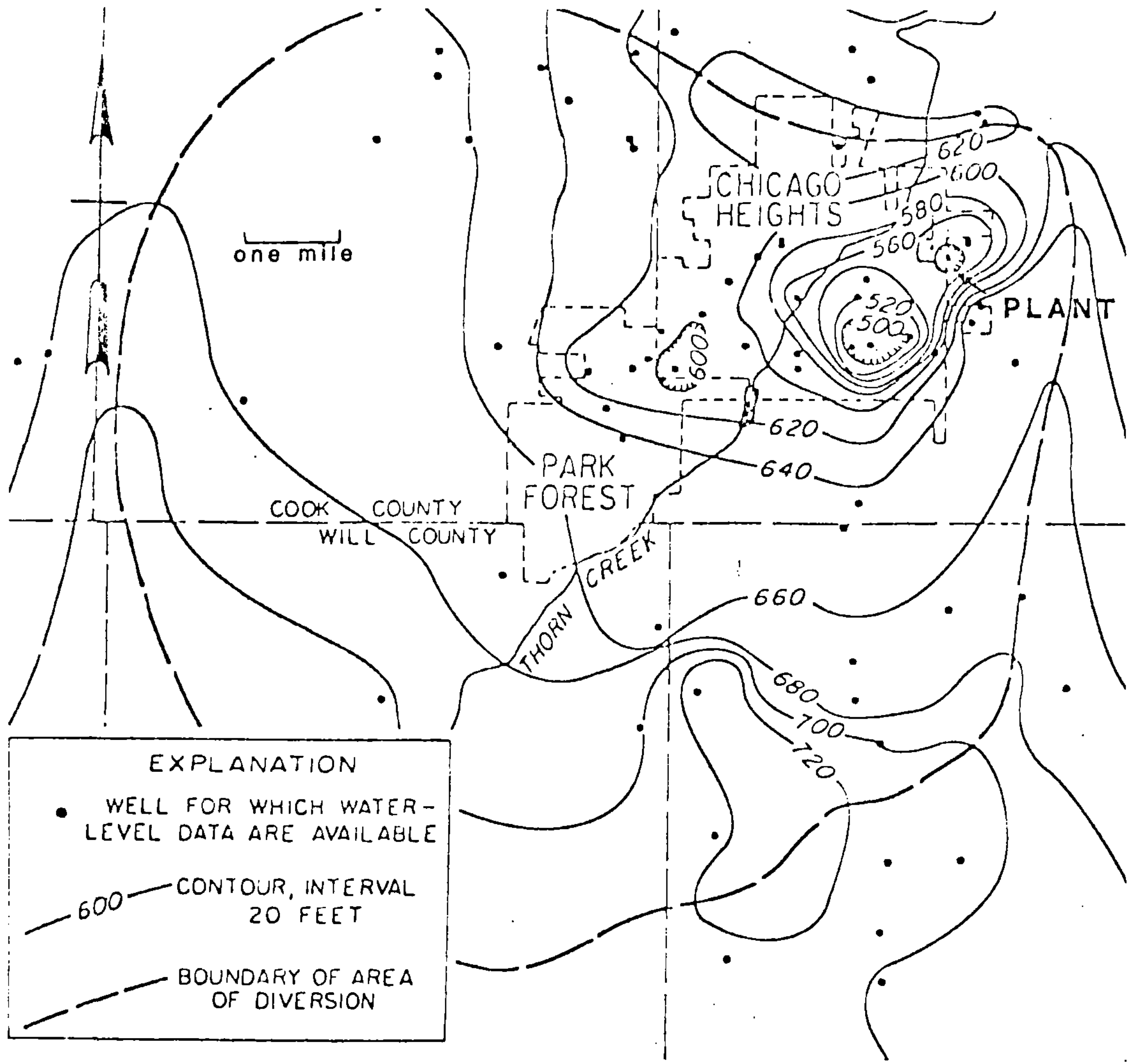
day per square mile). However, the hydraulic connection between the two units appears limited because water levels in the glacial drift do not usually coincide with the potentiometric surface in the dolomite aquifer (Prickett and others, 1964).

Silurian Dolomite Aquifer

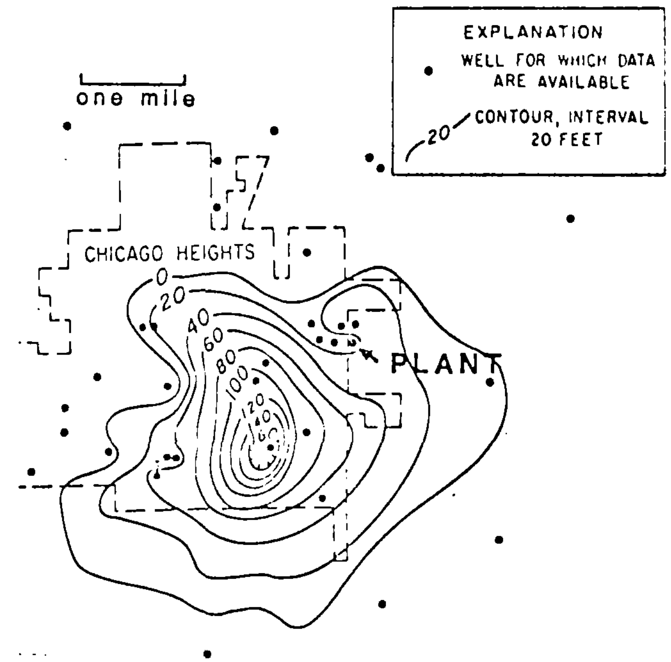
A Silurian-age dolomite formation occurs beneath the drift deposits covering the site (Table 1). This dolomite, approximately 400 feet thick, is a regionally-important aquifer tapped by many high-capacity municipal and industrial wells (Figure 1). Individual well yields of over 1000 gpm (gallons per minute) are not uncommon. Ground water occurs mostly under confined, leaky artesian conditions but there are some areas of water table (unconfined) conditions. In the Chicago Heights area, leaky artesian conditions prevail except where heavy pumping has dewatered the upper portion of the aquifer (Figure 2).

Water levels in the dolomite aquifer show a rapid response to recharge from precipitation. However, surficial sediments and/or low permeability beds in the upper part of the dolomite aquifer probably retard downward movement of water toward the main producing zones. Estimates of the aquifer recharge rate range from 177,000 to 225,000 gpd/sq mi (McDonald and Sasman, 1966; Prickett and others, 1964).

Average aquifer transmissivity at the plant is 21,700 gpd/ft (gallons per day per foot) and ranges from 2,000 to 41,000 gpd/ft



WATER LEVEL ELEVATION IN THE SILURIAN DOLOMITE AQUIFER, 1966. (From McDonald and Sasman, 1966)



DOLOMITE AQUIFER DEWATERING, 1962

(From Prickett and others, 1964)

FIGURE 2.
REGIONAL HYDROGEOLOGIC CONDITIONS

STAUFFER CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

(Table 2). The long-term gravity yield of the aquifer is 0.03.

In the past, the Chicago Heights plant relied mainly on the shallow dolomite aquifer to meet its water supply needs (Appendix A.2). Withdrawals from the plant production wells had a noticeable impact on the regional ground-water flow system. In 1966, this pumpage produced a large cone of depression at the plant (Figure 2). The regional flow system was controlled by withdrawals from the Inland Steel and Chicago Heights Municipal well fields located southwest of the plant.

Currently, PW-10 is the only plant production well using the dolomite aquifer as a water supply source. Recent water-level maps for the dolomite aquifer are not available, so the present effects of withdrawals from PW-10 are not known.

Cambro-Ordovician Aquifer

The Cambro-Ordovician aquifer is not a massive water-bearing unit but rather consists of a series of interbedded low-yield dolomite formations and high-yield sandstones. Regionally, the aquifer is very heavily developed with large-scale water supplies obtained from the Ironton-Galesville Sandstone and the Glenwood-St. Peter Sandstone (Table 1). It is not extensively used in the Chicago Heights area (Sasman, 1977), and PW-2 is the only plant production well tapping the Cambro-Ordovician aquifer (Appendix A.3).

Aquifer transmissivity in a municipal well near the plant is

Table 2. Silurian Dolomite Aquifer Hydraulic Characteristics, Stauffer Chemical Company, Chicago Heights, Illinois. (Data from Prickett and others, 1964.)

Well	Date of Test	Static Water Level (feet)	Discharge Rate (gpm)	Adjusted Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)
PW-1	1921	35	340	5.90	12,000
	1946	36	350	4.50	9,000
PW-3	1941	37	130	1.05	2,000
PW-4	1947	52	350	11.50	23,000
PW-5	1956	49	520	17.35	34,700
PW-6	1955	102	70	5.38	11,000
PW-7	1955	110	130	2.17	—
PW-8	1955	97	250	20.80	41,000
PW-9	No Data	-	-	-	—
PW-10	1956	95	500	20.50	41,000

Note: PW-2 which taps the Cambro-Ordovician aquifer was tested in 1942. At a discharge of 680 gallons per minute the specific capacity was reported as 5.3 gpm/ft.

1,600 gpd/ft. The average regional storage coefficient is 0.00035 for short time periods and 0.0006 for periods of several years or more (Suter and others, 1959).

A thick confining bed, the Maquoketa Shale, separates the Cambro-Ordovician aquifer from the overlying Silurian dolomite aquifer. The low vertical permeability of the shale (0.00005 gpd/ft^2) limits but does not prevent the downward movement of water under natural and pumping-induced gradients. Under a head differential of several hundred feet, the Cambro-Ordovician aquifer receives 1500 gpd/sq mi of recharge from the overlying dolomite aquifer (Prickett and others, 1964).

GROUND-WATER FLOW SYSTEM

Water levels in the plant monitoring and production wells were measured several times during May and August, 1981 (Appendix B). A water-level elevation map was compiled using measurements made from May 18 to 21, 1981 (Figure 3). On the basis of this map, the ground-water flow direction in the glacial drift aquifer is toward the south and southwest.

The hydraulic gradient is not uniform across the site, changing from 0.00048 north of the disposal area to 0.0076 south of it. Assuming a horizontal permeability of 25 ft/day (feet per day) for fine, silty sands and a porosity of 35 percent, the ground-water flow rate in the glacial drift aquifer is:

$$V = \frac{KI}{n}$$

where: V = velocity, ft/day
K = permeability, ft/day
I = ground-water gradient
n = formation porosity

North Area

$$V = \frac{25 \text{ ft/day}(0.0048)}{0.35}$$

$$V = 0.3 \text{ ft/day}$$

$$= 110 \text{ ft/year}$$

South Area

$$V = \frac{25 \text{ ft/day}(0.0076)}{0.35}$$

$$V = 0.5 \text{ ft/day}$$

$$= 182 \text{ ft/year}$$

The observed change in ground-water gradient is probably due to the influence of withdrawals from PW-10 or some other nearby pumping center. Pumping from production well PW-2 should not influence water levels in the glacial drift because these sediments, as well as the Silurian dolomite aquifer, are cased off.

Head differences in wells tapping the glacial drift aquifer and the Silurian dolomite aquifer indicate the hydraulic connection between the two water-bearing units may be limited. Water levels in production wells PW-3 and PW-9 are one to three feet lower than water levels in nearby monitoring wells (Figure 3).

Other evidence of a limited hydraulic connection is the apparent lack of drawdown in the drift aquifer due to pumpage from the dolomite aquifer. In May 1981, production well PW-10 was pumping at a rate of 118 gpm and significant drawdowns were observed in dolomite aquifer wells located 250 to 400 feet away. A comparable drawdown was not observed in monitoring well MW-11 tapping the drift aquifer 400 feet southeast of PW-10 (Figure 3).

From the information available, it appears that: 1) withdrawals from PW-10 do not significantly effect water levels and ground-water flow patterns in the glacial drift aquifer, 2) withdrawals from production well PW-2 do not significantly effect water levels in the Silurian dolomite aquifer and 3) flow in the glacial drift aquifer is not controlled by pumpage from the plant's wells.

Respectfully Submitted,
Bruce S. Yare and Associates, Inc.

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President

REFERENCES CITED

Hughes, G.M. and others, 1966. Bedrock Aquifers of Northeastern Illinois: Illinois Geological Survey, Circular 406, 15 p.

McDonald, C.K. and R.T. Sasman, 1966. Feasibility of Artificial Recharge in the Park Forest - Chicago Heights Area: Illinois Water Survey Special Report, 37 p.

Prickett, T.A. and others, 1964. Ground-Water Development in Several Areas of Northeastern Illinois: Illinois Water Survey Report of Investigation 47, 93 p.

Sasman, R.T. and others, 1977. Water-Level Decline and Pumpage in Deep Wells in the Chicago Region, 1971 - 1975: Illinois Water Survey Circular 125, 35 p.

Suter, M. and others, 1959. Ground-Water Resources of the Chicago Region, Illinois: Illinois Geological and Water Surveys Cooperative Ground-Water Report 1, 89 p.

Walton, W.C. and S. Csallany, 1962. Yields of Deep Sandstone Wells in Northern Illinois: Illinois Water Survey Report of Investigation 43, 47 p.

Willman, H.B., 1971. Summary of the Geology of the Chicago Area: Illinois Geological Survey Circular 460, 77 p.

Appendix A.1. Representative Soil Borings, Stauffer Chemical Company, Chicago Heights, Illinois. (Borings done in 1976 and 1977 by Walter H. Flood & Co., Hillside, Illinois. All measurements in feet below grade.)

BORING No. 2 (Location - 10+50N, 12+68E)

Depth	Description
0.0 - 0.5	GRAVEL
0.5 - 4.5	CONCRETE
4.5 - 15.0	CLAY - brown and gray, silty
15.0 - 25.0	CLAY and SILT - gray
25.0 - 28.5	SAND - fine to medium, with small to large gravel
28.5 - 38.5	BEDROCK - weathered dolomite

BORING No. 6 (Location - 12+65N, 12+60E)

Depth	Description
0.0 - 6.5	FILL
6.5 - 11.0	SILT - brown and gray, clayey
11.0 - 30.0	SAND - fine to medium, brown
30.0 - 33.0	BEDROCK - weathered dolomite

BORING No. 9 (Location - 16+15N, 12+85E)

Depth	Description
0.0 - 6.0	FILL
6.0 - 15.5	SILT - brown and gray, clayey
15.5 - 31.0	SAND - fine, gray
31.0 - 31.5	BEDROCK - gray dolomite

BORING NO. 10 (Location - 16+00N, 11+40E)

Depth	Description
0.0 - 5.0	FILL
5.0 - 6.0	CLAY LOAM - black
6.0 - 20.0	CLAY- brown to gray, silty
20.0 - 23.0	CLAY and SILT - interbedded, gray
23.0 - 30.0	SAND - fine, gray
30.0 - 33.0	SILT - gray, some fine sand
33.0 - 35.0	BEDROCK - gray dolomite

Appendix A.2. Geologic Log of Production Well PW-3, Stauffer Chemical Company, Chicago Heights, Illinois. (Data from Illinois State Geological Survey files. All measurements in feet.)

	Thickness	Depth
PLEISTOCENE SYSTEM		
DRIFT and FILL	36	36
SILURIAN SYSTEM		
Niagaran Series		
DOLOMITE - broken, slightly cherty, greenish gray to buff, very fine	9	45
SILTSTONE - broken, dolomitic, gray	19	64
DOLOMITE - creviced, pink to gray, silty	58	122
DOLOMITE - hard, very silty, greenish gray	30	152
DOLOMITE - soft, very silty, greenish gray, gray shale streaks	27	179
DOLOMITE - some crevices, gray to buff, fine, dense	50	229
DOLOMITE - greenish gray, fine, dense	25	254
DOLOMITE - white to gray, fine, dense water level dropped 12 feet at a depth of 291 feet	146	400
Alexandrian Series		
Kankakee Formation		
DOLOMITE - hard, buff, fine to medium, glauconitic, pyritic, slightly vesicular	33	433
ORDOVICIAN SYSTEM		
Edgewood Formation		
SILTSTONE - dolomitic, gray	—	433

Appendix A.3. Geologic Log of Production Well PW-2, Stauffer Chemical Company, Chicago Heights, Illinois. (Data from Illinois State Geological Survey files. All measurements in feet.)

	Thickness	Depth
PLEISTOCENE SYSTEM		
GLACIAL DRIFT(?)	36	36
SILURIAN SYSTEM		
LIME - blue, medium hard	69	98
LIME - white, medium hard	16	114
LIME - blue, medium hard	21	135
LIME - white	130	265
LIME - gray, fairly soft	165	430
ORDOVICIAN SYSTEM		
Richmond Formation		
SHALE	240	670
Galena-Platteville Formation		
LIME - white, hard	335	1005
St. Peter Formation		
SAND	120	1125
CAVE - no casing needed	25	1150
Oneota Formation		
LIME - white, hard	150	1300
CAMBRIAN SYSTEM		
Trempealeau Formation		
LIME - blue gray, very hard	180	1480

Appendix A.3. Geologic Log of Production Well PW-2, Stauffer Chemical Company, Chicago Heights, Illinois. (continued)

CAMBRIAN SYSTEM (continued)	Thickness	Depth
Franconia Formation		
SHALE - sandy	105	1585
SHALE - limey, hard	9	1594
SHALE - soft	21	1615
Dresbach Formation		
SAND - with some lime rock	70	1685
SAND - Potsdam	105	1790
Eau Claire Formation		
SAND and LIME	7	1797

Appendix B. Water-Level Information, Stauffer Chemical Company, Chicago Heights, Illinois. (Depth to water in feet below top of casing and elevation in feet above mean sea level.)

WELL	May 18 to 21, 1981 Depth to Water	May 18 to 21, 1981 Elevation	August 5 to 6, 1981 Depth to Water	August 5 to 6, 1981 Elevation
MW-1	30.01	615.67	28.68	617.00
MW-2A	28.21	612.45	26.93	613.73
MW-4	25.92	614.14	24.87	615.19
MW-5	23.03	614.53	21.81	615.75
MW-7	16.30	618.78	15.95	619.13
MW-8	10.56	623.43	11.47	622.52
MW-9	12.25	622.02	12.32	621.95
MW-10	18.73	618.44	17.52	619.65
MW-11	27.54	610.69	26.65	611.58
MW-12	41.28	602.16	39.63	603.81
PW-2(1	137	?	139	?
PW-3	32.58	607.39	31.41	608.56
PW-4	45.58	591.49	40.52	596.55
PW-6	36.75	?	34.56	?
PW-7	52.64	586.57	46.71	592.50
PW-8	29.91	?	28.07	?
PW-9	11.94	621.28	12.00	621.22

Note: 1) Measurement is airline reading in feet, length of airline not known. Sasman and others (1977) reported a water level elevation of 133 feet above msl for this well.